Infrastructural instability, value, and laboratory work in a public hospital in Sierra Leone

MAT Medicine Anthropology Theory

RESEARCH ARTICLES

Infrastructural instability, Value and Laboratory Work

in a Public Hospital in Sierra Leone

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Received: 1 October 2020; Accepted: 19 March 2020; Published: 18 June 2021

Abstract

This research article examines the relationship between infrastructural instability and laboratory work in a public referral hospital in Sierra Leone. Drawing on ethnographic fieldwork conducted inside the hospital's wards and clinical laboratory, I show how attending to infrastructure and materiality (i.e., laboratory spaces, diagnostic equipment, and supply chains) provides insight into the different kinds of value that laboratory work holds for laboratory technicians, clinicians, hospital administrators, and international donors. Through the case study of a newly arrived non-functioning diagnostic instrument, I reveal the institutional undervaluing of both the laboratory and the improvisation work performed by lab technicians to stabilise unstable equipment. Infrastructural instability in the laboratory enables the generation of new kinds of value, including economic and social value for laboratory technicians themselves, but undermines the clinical value of laboratory tests for clinicians and patients. By discussing the everyday practices, challenges, and meanings of laboratory work in a context of infrastructural instability, I aim to draw attention to the clinical laboratory space as a field site worthy of (more) anthropological inquiry and health systems research and contribute new insights about improvisation, instability, and diagnostic value creation in under-resourced settings.

Keywords

Laboratory ethnography, Diagnostics, Instability, Infrastructure, Sierra Leone.

Medicine Anthropology Theory 8 (1): 1–24; ISSN 2405-691X; https://doi.org/10.17157/mat.8.2.5167.

Introduction

> ‘Us, the lab technicians, we are important, but people don’t know; for the doctors we are their sorcerers, we investigate for them and tell them, “This is the problem for your patient.”’ — Laboratory technician, Freetown, February 2019.

Clinical laboratories have long been a neglected component of health system planning and global health investment in Sierra Leone, as is the case in many other low- and middle-income countries (Ondoa et al. 2017). In recent years, however, laboratory strengthening has received more attention, particularly in response to infectious disease outbreaks considered global health security threats, such as the 2014–2016 West African Ebola outbreak and the current COVID-19 pandemic (Nkengasong et al. 2018; Okeke 2020). The Ebola outbreak exposed significant gaps in Sierra Leone’s laboratory system, prompting a wide range of international assistance in terms of emergency preparedness and laboratory strengthening efforts during the outbreak and its aftermath (Wurie 2016). These investments included, for example, the provision of mobile laboratories meant to upscale Ebola in-country diagnostic capacity; technical assistance in the development of national-level laboratory and surveillance systems as well as policy frameworks; and infrastructural investments to refurbish or build entirely new laboratories, hospitals, and training programmes (Vernooij et al. 2020).

What do these infrastructural investments tell us about the value of laboratory work for (inter)national governments and donors? And how do refurbished laboratory spaces, new diagnostic instruments, and laboratory supplies affect the value of laboratory work for laboratory staff, clinicians, hospital administrators, and patients? In this research article, based on ethnographic research conducted inside the clinical laboratory of Sierra Leone’s main public referral hospital, I explore the everyday practices, challenges, and meanings of conducting laboratory work during a period of post-Ebola laboratory strengthening efforts. In doing so, I aim to explain why, despite recent infrastructural investments, laboratory staff feel undervalued as contributors to processes of diagnosis and patient management (as the opening quotation suggests).

Generally speaking, ethnographic research conducted in and about laboratories sits at the intersection of anthropology and science and technology studies (STS). Foundational STS scholarship concerning laboratory work (Knorr 1977; Lynch 1985; Latour and Woolgar 1986) took place inside well-resourced research laboratories in the Global North and studied laboratories as locations where

scientific knowledge was socially constructed and stabilised.[1] In STS analyses and particularly actor-network theory (ANT) studies (e.g., Callon 1986; Latour 1987; Law 1992), the focus has been on understanding how human actors (laboratory technicians, research scientists) and non-human elements (microbes, texts, laboratory instruments) are connected, coordinated, and stabilised in a network of associations; an actor-network (Mol and Law 1994). The focus on the stabilisation of knowledge practices in research laboratories was later extended to analyse the (in)stability of laboratory work in hospital settings, where the production of knowledge is geared to inform diagnosis and clinical decision making (Singleton 1998; Mol 2002). In her ethnographic study on the role of the laboratory in a well-established UK cervical screening program, Vicky Singleton (1998) challenged the actor-network theory, which posits that a network is maintained by the stability of its socio-material elements. Rather, she argued that the ability of laboratory staff to deal with instabilities, such as ambivalences in screening or sample-taking procedures, contributed to the long-term stability of the screening programme. Informed by Singleton's analysis, I explore the kinds of instability that laboratory staff deal with in Sierra Leone, a low-income country where laboratory spaces are often experienced as places of infrastructural shortages (Tousignant 2013).

Ethnographic work in under-resourced research laboratories in African settings has generally focused on what it means to do science in postcolonial settings characterised by unstable infrastructure and the ways in which this instability shapes African scientists' dreams and identities (e.g., Droney 2014; Tousignant 2013; Okeke 2020). Similarly, hospital ethnographies undertaken in under-resourced settings have discussed how unstable laboratory infrastructures have shaped clinicians' diagnostic practices (e.g., Livingston 2012; Street 2014; Wendland 2010). Alice Street, in her ethnography of a public hospital in Papua New Guinea, explains that diagnostic tests were often unavailable or that results arrived (too) late—or, if results did arrive on time, doctors often distrusted them because the laboratory's diagnostic equipment had not been well installed and was not well maintained (Street 2014). This meant that diagnostic tests had little clinical value for clinicians. Others studying hospital infrastructure in African settings have noted the importance of improvisation and the creativity of health workers in stabilising healthcare service delivery during times of medicine and diagnostic material shortage (e.g., Mika 2020; Umlauf and Park 2017). Yet limited attention has been paid by scholars to how infrastructural instability affects laboratorians' everyday work. This may be due to how few ethnographic studies have been

1 See Doing (2008) for a critical reflection on the limitations of early laboratory studies in studying the stabilisation and endurance of scientific facts.

conducted inside clinical[2] laboratories in low-and middle-income countries (cf. Carsten 2019).

I aim to contribute to these debates on infrastructural instability and laboratory work in anthropology and STS by exploring how laboratory staff deal with material instabilities in their everyday work and the ways in which instability affects the kinds of value laboratory work represents for laboratory workers, patients, clinicians, and hospital managers. Anthropologists writing about value have put forwards different definitions of what value is, which range from general conceptualisations of value as anything which is 'beautiful, or worthwhile, or important' (Graeber 2002, ix) to economic conceptualisations of value as commodified goods and services (Appadurai 1986). In this research article, I build on anthropological inquiries into the different 'types' of value—also referred to as 'regimes of value' (Appadurai 1986)—that seek to understand the multiplicity of value by following the movement of material things in and out of different contexts (see, e.g., Valk 2020). In my study of everyday laboratory work, I suggest that the value of diagnostic tests and laboratory equipment is shaped by the institutional context in which they are situated, signifying that the values of things, people, and spaces are interrelated. Therefore, I prefer to speak of the value of laboratory *work* and to study value as it 'emerges in action' (Graeber 2002, 45) by drawing attention to the role of human and institutional elements in the generation of value.

In my analysis, I focus on how infrastructural instabilities—caused by external political and economic realities (e.g., unstable supply chains, elections) as well as by internal institutional and material relations (e.g., distrustful clinicians, unreliable diagnostic equipment, etc.)—shape laboratory practices. I argue that these instabilities expose the limited clinical value of laboratory work for clinicians and hospital administrators. Laboratory staff respond to infrastructural instabilities by privately purchasing and selling laboratory supplies to fill the gaps in government and hospital supply chains, which enables the continuation of services to patients who cannot afford to visit private laboratories instead. In this way, they generate economic and social value for laboratory staff and their families. Furthermore, recent infrastructural refurbishments of the laboratory space suggest that the value of laboratory work to international governments and donors is primarily focused on enabling the diagnosis of diseases considered global security threats, such as Ebola and COVID-19; there is little value associated with the improvement of

2 The demarcations between research and diagnostic work in clinical versus research laboratories is not clear-cut. There are clinical laboratories were research is conducted alongside diagnostic work, yet often those findings are not used to inform clinical diagnosis. However, as Wilkinson's ethnographic study of a research laboratory in Sierra Leone (2013; 2017) shows, whilst laboratory tests might be designed for research purposes only, in practice they were used by clinicians to inform clinical practices (though test results were often not shared with patients).

routine laboratory capacity in order to diagnose common diseases and improve patient management.

The research upon which this research article is based was conducted as part of the European Research Council-funded DiaDev research project (www.diadev.eu), which seeks to understand the social, cultural, and technical processes involved in developing, deploying, and using diagnostic devices in resource-limited settings (Street 2018). My ethnographic fieldwork consisted of six months of participant observation between October 2018 and March 2019 (with short follow-up visits in May and September 2019) inside the clinical laboratory and wards of Connaught Hospital in Freetown, Sierra Leone. I also conducted 33 interviews with the hospital's laboratory staff, clinicians, and administrators. Additionally, with the help of a research assistant, 15 hospital patients who presented with complaints of fever were accompanied through (most of their) diagnostic trajectories at the hospital. Often the diagnostic work was situated in different locations at the same time; in such situations, my research assistant followed the patient while I concentrated on the work of the lab technicians and tried to follow the samples to the laboratory. Furthermore, 11 other laboratories in Sierra Leone where diagnostic testing or research took place during the Ebola epidemic (including private, research, and reference laboratories) were visited so that I could build up a broader understanding of the impact of the Ebola epidemic on laboratory work. Ethical approval for the study was granted by the Sierra Leone Ethics and Scientific Review Committee and the University of Edinburgh's Research Ethics and Integrity Committee.

In March 2018, a few months before I was due to start my fieldwork, Sierra Leone had a general election, following which the opposition leader, Julius Maada Bio, of the Sierra Leone People's Party, took office. Sierra Leone, since gaining independence in 1961, has had a two-party political system divided along geographic and ethnic lines (Kandeh 1992). Besides appointing new ministers, the election had a direct effect on the running of Connaught Hospital, with several heads of department replaced because of their association with the incumbent political party, the All People's Congress. A newly established Directorate of Laboratory, Diagnostics and Blood Services within the Ministry of Health and Sanitation was installed and one of its first acts was to review the skills and qualifications of all the government-employed laboratory staff. This review led to the reposting of 36 laboratory staff nationwide in June 2019, 20 of whom—nearly the entire lab staff—worked at Connaught. This mass reposting reflected the then-current political positioning of the hospital. Conducting fieldwork just after the elections was tricky, in part due to the hospital's political importance as the country's main teaching and referral hospital; staff were hesitant to say or do anything that could affect their employment status.

In the following sections, I discuss the infrastructural instabilities laboratory staff in Connaught Hospital frequently need to improvise around and examine what these instabilities reveal about the value of laboratory work for international governments, hospital managers, clinicians, and laboratory staff. In these sections, I have integrated information about historical investments in laboratory services in Connaught Hospital with that of investments in Sierra Leone more generally so as to situate the discussion of the value of laboratory (or lab) work in a wider political-economic context. As part of this discussion, I explore the implications of an anthropological approach to infrastructural instabilities for use in future laboratory-strengthening interventions.

Infrastructural instability and the institutional value of the laboratory

Connaught Hospital is Sierra Leone's main adult referral and teaching hospital and is located on the shore of the Atlantic Ocean on the northern edge of Freetown, the nation's capital city. Established in 1909, it replaced the city's Colonial Hospital, where care had been administered on a racially segregated basis (Hirsch 2019). In the first years following 1961's independence, the hospital was described as a state-of-the-art institute with various specialised doctors, but years of limited government investment and Sierra Leone's civil war (1991–2002) led to the deterioration of its services and an outflux of many of its staff abroad (Walsh and Johnson 2018). After the war, efforts to rebuild the health system were dictated by debt relief conditions and focused on decentralisation, community financing, and support for a private sector that had grown substantially during the war and ultimately replaced many of its closed public-sector counterparts (Shakow, Yates, and Keshavjee 2018). The aftermath of these events is still visible today in the range of private clinics and laboratories that populate the streets surrounding Connaught Hospital, some headed by medical doctors who simultaneously work at Connaught.

Present-day Connaught has an ambiguous reputation as the country's 'number-one hospital' (as the main referral and teaching hospital), but this reputation co-exists with a more negative public perception of Connaught as 'the place you go to die' (Walsh and Johnson 2018). The hospital receives limited commodities from the government and stock-outs of medicines and other essential supplies are common (Brooks and Herrick 2019). The hospital building itself reveals its years of neglect; brown and white paint peels from the thick brick walls and the pharmacy's shelves are often empty. At night, the hospital's wards are filled with mosquitos, and cockroaches scuttle over the cement floors. A running joke among medical graduates (also called 'house officers' or 'junior doctors'), who make up a large proportion of the hospital's doctors, is that if you do not have malaria when

you enter the hospital, you'll certainly get it if you stay the night. For that reason, they try their best to avoid spending the night in the hospital.

In contrast to the deteriorated infrastructural state of the hospital, at first glance Connaught's clinical laboratory looks impressive: its sterile all-white interior is filled with several pieces of expensive-looking equipment, results of the post-Ebola laboratory strengthening projects that were conducted by the UK government's Public Health England (PHE). PHE's investments focused primarily on the establishment of a molecular diagnostic department, where automated reverse transcription-polymerase chain reaction (RT-PCR[3]) devices were installed to test for Ebola. Whilst the Ebola outbreak seemed to significantly increase the country's capacity to diagnose Ebola, little investment was made in improving general laboratory capacity (in microbiology, haematology, and biochemistry), which is vital for informing the management of patients suffering from Ebola (and any other illness for that matter [Ansumana et al. 2019]). Yet, as will become clear throughout the following sections, despite these recent infrastructural investments, laboratory staff have struggled to make diagnostic tests available to patients.

Connaught's clinical lab is reached through a hallway and is only accessible to lab technicians who know the code for the locked door. The main lab is divided into four areas: microbiology, haematology, biochemistry, and the molecular department. The microbiology area is the most spacious, and the air-conditioning works on this side of the lab, keeping it cool. There are different pieces of equipment, such as drying ovens, refrigerators, incubators, microscopes, and an autoclave, some of which work, while others have notes affixed stating 'faulty, not working now'.

On the shelves there are leftover reagents (chemicals used to process tests), including agar (used for growing bacteria cultures), from past research projects, including those brought in for a PHE project focused on cholera testing in response to the severe floods and mudslides in Freetown in 2017. Whilst PHE's cholera preparedness was an emergency response project, its effects were longer-lasting because the responsible laboratory lead ordered ample amounts of reagents that he knew would last for years to come. Whilst these supplies were certainly useful in helping build up the skills of laboratory staff members, culture and sensitivity testing was not at the time of fieldwork widely available to the hospital's patients, and was only conducted as part of a bachelor's-level student's research project. Making culture testing available to all patients would require sustained material infrastructural investments, such as reliable electricity for growing cell cultures in an incubator, consistent supply chains of laboratory consumables (e.g., Petri

3 RT-PCR testing is seen as the gold standard for Ebola testing, as it is for most viral infections.

dishes), and additional training of laboratory personnel besides the bachelor's-level student. Besides the onsite training of lab personnel in microbiology, long-term infrastructural investments in electricity and supply chains were not made.

In the middle of the microbiology space, there are lab benches where microscopy for urine analysis, malaria testing, and blood cell counting is done. On the right side of the room is an area for serology, including rapid tests for hepatitis B and C and *H. pylori*. The use of rapid tests without follow-up confirmatory testing is remarkable for a (referral) hospital; such devices are designed for and used as screening tests in places without dedicated laboratory spaces. In Connaught, then, technologies designed to provide preliminary clinical diagnoses in places without laboratory infrastructure have come to replace or diminish existing laboratory capacity.

During my fieldwork, the molecular department was not testing for Ebola or any other disease because there were no reagents (see Vernooij 2019 for a more detailed discussion of the molecular department). In order to keep up their knowledge of the molecular techniques in which lab technicians had been trained during the Ebola epidemic and its aftermath, lab staff watched animated YouTube videos of RT-PCR analyses during breaks.

Other areas of the main laboratory included the haematology and biochemistry areas, which filled a smaller room containing two semi-automated pieces of equipment: a haematology analyser (which provided full blood count testing, a standard requested test for any patient admitted to the hospital) and a biochemistry analyser, which could run liver function tests, kidney function tests, and electrolyte counts. For many of the laboratory staff, these automated machines were symbols of modernity and were seen as a possible means to increase the value of their work and better contribute to patient care, predominantly by increasing the confidence of clinicians in the lab and motivating them to refer (more) patients to the lab. This was made clear by the efforts laboratory staff exhibited in integrating a newly arrived non-functioning piece of equipment (a haematology analyser), which they referred to as the 'fake machine'.

The unstable machine

The haematology analyser (an instrument used to analyse whole blood samples) had arrived in the laboratory a few months before I started fieldwork, and had been delivered by an engineer from the Sierra Leone government's Pharmaceutical Procurement Unit, itself a part of the Ministry of Health and Sanitation. Since its inception in 2012, the Pharmaceutical Procurement Unit's primary role has been to manage the distribution of drugs, but it also manages laboratory equipment despite not having much expertise in the field of diagnostics (Barr et al. 2019). It

has recently undergone reform, partly because of its alleged corruption and the frequent cases of missing commodities, and is currently known as the National Medical Supplies Agency (Ibid). One laboratory scientist employed through the World Bank was present at the time the device was delivered to the hospital laboratory and explained that the machine was delivered without a starting pack of reagents and neither installed nor calibrated—it was therefore not functional. The introduction of a new instrument is generally accompanied by an assemblage of social and technological components, of which the former refers to a company technician or bioengineer who installs the machine and trains the lab staff on the instrument's use and maintenance. The latter technological components refer to the provision of a proper supply chain for reagents and consumables and a service contract and warranty in case of breakdowns, thus ensuring the continued operation of the machine. These assemblages are crucial to ensure the quality of the instrument's results, but have historically been lacking in many African countries (Feagins et al. 2019: Okeke 2011).

Because of the brand name (BIOBASE, a Chinese diagnostic manufacturing company) displayed on the machine's cover, a volunteer working for the international organisation King's Sierra Leone Partnership (KSLP) and based in Connaught hospital was able to find a manual written in Chinese on the internet, which she translated to English using Google Translate and printed for laboratory staff. The World Bank laboratory scientist decided to phone BIOBASE to enquire about the machine and reagents, and a representative informed her that they were not aware of any transaction related to the machine. When the scientist took a closer look at the machine, it became evident that the machine's cover did not match the rest and that the blue letters displaying the BIOBASE brand name were crooked and appeared to have been applied manually. The staff concluded that the machine was a fake. With the help of a contact at a private laboratory who regularly ordered reagents from China, a laboratory scientist working with KSLP managed to install the machine and trained the laboratory staff to use it. Meetings were subsequently arranged with the hospital's consultants to announce the successful installation of the blood analyser in order to generate interest in the machine.

Although it was not a genuine BIOBASE machine, the instrument was nonetheless highly valued by the laboratory staff. The machine substantially shortened the time it took to provide results (previously, lab scientists had to perform full blood count analyses by counting the different kinds of cells under the microscope) and provided a wider range of laboratory values. An additional benefit was that the machine provided printed results, something which the staff felt would increase clinicians' confidence in laboratory results. Additionally, lab staff deemed the

machine less risky than performing manual tests, which involved more direct contact with blood.

One laboratory technician who had recently started working with the machine explained that the number of samples was increasing; she interpreted this as a sign that clinicians believed the machine had clinical value. The machine was used for some months, but, when the laboratory ran out of reagents, hospital management did not purchase replacements, and so the laboratory staff reluctantly went back to using manual methods of microscopic cell counting. When a female laboratory technician who'd grown used to working with the machine came back after her maternity leave, she was disappointed to find the machine no longer in use and stated that it felt like the lab had gone 'twenty steps back'. Another male lab technician stated that a machine without reagents was 'like having a brand-new car but not having fuel'. However, another lab technician mentioned that he had doubted the quality of the machine's results because of ongoing problems with its calibration. Beyond these 'technical' problems, the lab staff member recounted a 'managerial' reason underlying the discontinuation of the haematology analyser, related to the financial management of the revenue generated by the machine. Whilst the laboratory had kept track of the revenue generated by the machine for the first three months of its use, the payment for lab tests was centralised at the hospital's 'bank', itself managed by the hospital administration. Whilst the lab calculated that the revenue was enough to replenish the reagents, the profits from the haematology analyser were not ring-fenced and were therefore used by other hospital departments. These institutional practices affected the lab staff's ability to sustainably use the machine and implied a limited recognition of the value of the laboratory among the hospital's management team. The laboratory staff considered purchasing the lab reagents by themselves, but, according to one lab worker, the cost of these particular reagents was too prohibitive (~800,000 leones, 60 GBP).

The story of the haematology machine shows the importance of lab staff's ability to improvise and to incorporate new or recycled technologies into their everyday work. Improvisation has been described by anthropologists as an essential part of practising biomedicine in settings of extreme resource shortages (Wendland 2010; Livingston 2012) and as integral to dealing with infrastructural instability related to stock-outs of medicines and diagnostic technologies (Umlauf and Park 2018). Yet, in an ethnography of a Ghanaian research laboratory, Damien Droney (2014) described how lab staff also exhibited feelings of shame regarding improvisations in lab practices (such as recycling consumables), which they dismissively referred

to as ‘African science’.[4] In Connaught laboratory there was also ambivalence regarding the use of the haematology machine, especially among visiting lab staff with international laboratory experience, who stated that the machine was a ‘serious embarrassment’ to the lab. The majority of the lab staff however seemed glad to be working with the machine, which could possibly improve the efficacy—and thus the status—of their work. Yet as several scholars studying technological and biomedical innovations in Africa argue, it is important not to romanticise improvisation in conditions of scarcity, as people are simply ‘making do with what they have in hand’ (Hecht 2012 in Twagira 2020). Indeed, many lab technicians frequently commented that they desired fully automated machines instead of semi-automated machines, like the devices they had seen in other West African countries.

I was not able to gather quantitative data about whether the haematology analyser indeed increased the number of patients in the laboratory, but I observed the lab to be fairly calm; there were usually no more than five patients waiting to have their samples drawn. According to the reception ledger, during a week in February 2019 (and shortly after the haematology machine had stopped working), 148 patients had their samples drawn (between 14 and 40 patients per day). For a 300-bed hospital which was nearly always full, this was not a large number. During a busy morning in triage, the nurses would see about 60 patients, which meant that a large proportion of the patients were not referred to the hospital laboratory by the consulting doctors. In the next section, I will describe the ways in which medical doctors’ diagnostic practices were shaped by previous experiences with questionable lab results and explore how these experiences have affected the perception of the clinical value of lab tests for clinicians and, by extension, their patients.

Clinical value of laboratory tests for clinicians

Upon arrival at the hospital, patients are directed to the emergency department, a chaotic place commonly filled with ambulances, cars, and *kekes* [tricycles] dropping patients off and people waiting to be seen by a doctor in one of the consultation rooms. Here, patients are triaged by nurses. Blood pressure is measured and a blood glucose test is performed by a nurse. Whilst the glucose test ought to be covered in the 25,000 leones (~2 GBP) registration fee patients pay before entering the triage, the nurses claim that hospital management does not provide enough test strips; therefore, they end up buying the glucometer and test strips themselves and charge patients directly. Next, a resident doctor or a

4 The current COVID-19 pandemic has shown that health workers in otherwise well-resourced health systems also improvise during times of resource shortage by improvising personal protective materials or pooling laboratory samples, but this may be regarded as a temporary exception rather than a common state of affairs (Wiedner et al. 2020).

house officer examine the patients. During their consultations, doctors often request diagnostic tests at the same time as prescribing drugs, as it usually takes at least 24 hours to get test results back from the laboratory and they do not want to send patients home without treatment. Patients who are severely sick are normally admitted, while others are asked to come back the next day or after three days. It is generally left up to the patient to decide whether to go to the lab and complete the tests or whether to simply take the prescription medication. At times, doctors discuss with patients (especially in-patients) whether it is in their means to visit a private laboratory instead of Connaught. They explain to patients that they trust the tests conducted outside of Connaught Hospital more than those conducted within (a [mis]trust often born of their own experiences and those of their seniors, the consultants). In an interview, a consultant explained that his mistrust in Connaught laboratory was related to two things that he perceived to be lacking (which were available in the private sector): adequate means to perform quality tests and adequate supervision and monitoring of the performance of health workers, including laboratory staff. He argued that, in his experience working in different private and public hospitals in the country, private health workers (including doctors and nurses) who had the same training as health workers in Connaught were performing better. Another consultant argued that it was the confidence she had in the laboratory institution itself that determined whether she trusted the laboratory results presented to her. A junior doctor explained his experience of Connaught laboratory, which made him doubtful of its quality:

> We get the electrolytes and we find out that on certain days you'll have ten patients having the same blood work. You see the same numbers. If malaria parasites, you see 80 on all the labs. So you're wondering how is that possible for every person to have the same lab? So there has to be inaccuracy somewhere.

Besides the clinical lab, the quality of the X-ray department was described as 'iffy' by one of the consultants, and ultrasound capacity was questioned too—as a house officer phrased it during a ward observation, 'The quality of the ultrasound is not ideal; they usually tell us everything is enlarged.' However, the house officers still use the clinical lab in Connaught, especially for patients who can't afford to pay the higher fees at private laboratories; they always keep in mind, however, that the results might be wrong.

During observations in the emergency department, I found it was uncommon for doctors to explain the meaning and importance of the requested test to patients, or to mention suspected diagnoses to patients, as noted in other anthropological works on diagnosis in Sierra Leone (Benton 2015; Wilkinson 2013; 2017). It was primarily the patients' responsibility to check up on the availability of lab results

and ensure they made their way back into the hands of the doctors. Connaught doctors' tendencies to not explain the meaning or importance of laboratory tests or to actively follow up on results illustrate the small clinical value of tests in the eyes of clinicians. This limited reliance on laboratory results to make clinical decisions is or has been a reality in many countries where inadequate laboratory infrastructure has affected the availability and quality of tests (Mol and Law 1994; Livingston 2012; Street 2014). Mol and Law (1994, 662) argue that Dutch 'tropical doctors' learned to rely on their clinical gaze to diagnose anaemia when working in African countries in the late 20th century, making diagnoses based purely on signs and symptoms rather than laboratory tests, which was not considered problematic: 'For the clinician the world does not collapse in the absence of a laboratory.' They make the point that the clinical value of a laboratory test is dependent on the context in which it is used; for example, during the war in Mozambique, when food rich in iron was scarce, a low haemoglobin measurement would not say as much as it would when observed in a well-equipped referral hospital laboratory in Harare, the capital city of Zimbabwe.

In Connaught Hospital—which is, after all, the main teaching and referral hospital in Sierra Leone's capital city—untrustworthy test results are considered problematic, especially by junior doctors, who are still in training. Many of Connaught Hospital's patients are severely sick, having been referred from other regional hospitals, and the first thing that the house officers do for admitted patients is request a wide variety of tests so as to get as much information about the patient as possible. As many patients are poor and cannot afford the tests, a group of junior doctors recently founded the Patient in Need Trust Fund to pay for laboratory tests and medication. They arranged a partnership with two private laboratories across the street from Connaught, each of which now provides free tests for one patient per week. As so many patients are in need, they implemented strict eligibility requirements: patients need to have been in the ward for three days without any lab investigations completed and without any relative visiting (it is assumed visiting relatives would be able to pay for the test). Even with these requirements in place, there are often more patients on the list than the private laboratories can serve. This shows that, especially for junior doctors, a high-quality laboratory is of undeniable value, as accurate laboratory results help them feel confident they are making correct diagnoses and patient management decisions. From the perspective of the medical doctors, sending a patient to a private laboratory is in the best interest of the patient. However, as a result of this collaboration with private laboratories and the wider mistrust of doctors (from senior consultants to junior doctors), few patients are sent to Connaught's laboratory, thereby limiting its value in terms of its contribution to clinical management.

The social and economic value of laboratory work

With regards to their relationships within the hospital, the lab staff frequently lamented being undermined by the hospital's clinicians. The lab staff saw the private laboratories across the street, and especially those run by hospital consultants, as competition, and also argued that doctors were financially motivated to send patients to private laboratories as they allegedly received a cut from these private laboratories based on the number of patients they referred. Furthermore, the lab staff recounted feeling undervalued by both the hospital administration and their government, citing the frequent interruption of their work by shortages of laboratory supplies.

The description of the laboratory as a space of shortages is echoed in other anthropological work on laboratory medicine in West Africa (Tousignant 2013), but at the same time is resisted and debunked in order to refrain from the framing of Africa as a place of 'absence', 'lack', and 'non-being' (Mbembe 2001 in Droney 2014). In a historical account of laboratory medicine in Senegal, Noemi Tousignant (2013) reflects on laboratory staff reminiscing about past times when international research projects brought in ample resources and automated 'machines'. However, when I spoke to laboratory staff in Connaught, I found very little nostalgia for past times; quite the contrary, in fact, as the work of laboratory technicians had not been highly regarded or rewarded historically. Connaught's clinical laboratory received several microscopes from the World Health Organization (WHO) in the past, but, according to the staff, it was not a site where automated machines or other high-end laboratory equipment had, at least in recent years, been available.[5] This explains staff members' initial enthusiasm about the unstable and semi-automated haematology analyser.

It was only in 2009 that Sierra Leone's government drafted its first national medical laboratory policy and that laboratory services became included in the Basic Package of Essential Health Services, which outlined the infrastructural needs of laboratories at different levels of the health system (MOHS 2010). One of the major impediments to establishing quality laboratory services was the lack of well-trained laboratory staff. An interviewed Sierra Leonean laboratory scientist, who trained in biomedical sciences in the UK and returned to Sierra Leone in 2010, was shocked by the lack of properly trained laboratory personnel working in the laboratories. Prior to his arrival back in Sierra Leone, there were only two certified colleges in the country providing two-year diplomas to become qualified as a laboratory technician. Despite these qualifications, he explained, the skillset of the lab

5 Most of the laboratory staff working in Connaught were in their 30s and had not worked in the laboratory for more than 10 years. As such, the historical perspective I present here is limited. For a more detailed historical account of laboratory system development in Sierra Leone, see Vernooij et al. 2020.

technicians was limited. This was partly because there were uncertified people working in the laboratories (some of whom did not even hold a secondary school diploma) and partly because there had been limited opportunities for professional development. In 2015, the first undergraduate degree programme in laboratory sciences was introduced in the University of Sierra Leone's College of Medicine and Allied Health Sciences, the country's first medical school, and was seen as an important step forwards by laboratory technicians. Indeed, the programme seemed to hold symbolic value to some of the laboratorians interviewed, many of whom understood it as a sign that the government had finally recognised 'the lab as part of medicine'.

Feelings of neglect from the government and hospital management were exacerbated by the personal and social risks lab workers endured during the Ebola epidemic of 2014–2016. Healthcare workers were among those most severely affected by the outbreak, with an estimated 295 infected and 221 killed, representing 21% of Sierra Leone's health workforce (GoSL 2015). In Sierra Leone, laboratory workers had the second-highest number of occupational infections, after nurses (WHO 2015). Connaught's clinical laboratory remained open during the outbreak, but Ebola testing was done elsewhere in Ebola-specific labs. Instead, Connaught's laboratory staff were involved as phlebotomists—they drew blood samples from Ebola-suspected patients in the King's Sierra Leone Partnership (KSLP)-managed holding unit and ran other laboratory tests for the few non-Ebola patients who continued coming to the hospital. In interviews, lab staff described being exposed to infection through the lack of personal protective equipment (PPE), which resulted in rising numbers of occupational infections and deaths among lab staff across the hospital and country. In order not to worry their family members, some laboratory staff told me that they concealed the fact their work involved taking samples from suspected Ebola patients from their families. Others described how their involvement in the Ebola response made them self-isolate for nearly two years from their family members in order to avoid infecting them. Clearly then, the laboratory was a risky place during the Ebola epidemic, both for oneself and for one's close family members, but lab staff continued working because they saw their work as important and knew that it helped to save lives. They thus saw the laboratory as a site for generating social value.

During my first weeks of fieldwork, I didn't notice how the shortage of reagents and tests affected laboratory work. It was not talked about (at least not with me) and diagnostic tests were being conducted in all the main laboratory areas except for the molecular department. It was only after I started taking part in social activities with laboratory staff— eating breakfast at the market outside of the hospital, for example—that I learned that the laboratory staff were buying their own reagents for commonly requested tests, including the Widal test for typhoid and rapid test

strips for urinalysis and hepatitis B and C. Such purchases were framed by laboratory workers as humanitarian acts; one of them explained that ‘in order for us not to shut down, the lab had to buy reagents’. He explained that the laboratory staff came together and, out of ‘humanitarian feelings’, bought reagents directly from a local diagnostic supplier. Instead of accepting the laboratory as a place of shortages, the laboratory staff took matters into their own hands. Another male lab technician member said:

> Because you are human yourself, amidst all other challenges, if there are things you can do to save life, you can go the length to save this life. But especially you are working for your country and you are working for humanity. So if, as somebody who is abled, you have means of assisting people irrespective of all the challenges, you can come out of those challenges and then you have to save life.

The notion of ‘humanitarian’ seems to refer to a presentation of laboratory work as of social importance for the public good. Another male laboratory staff member explained that some of the lab staff wanted to be able to bring their own children for testing and so needed the tests available, meaning such purchases were also in their own (family) interest. Furthermore, he argued, if clinicians had to send patients to get tested in private laboratories, they would have to pay very high prices. Hence, the social value of laboratory work, beyond its capacity to provide access to medical testing in the interest of the wider public, was seen to also refer to the benefits of laboratory work within the social network of laboratory staff themselves. In a recent ethnography about the multiple meanings of blood in Malaysia, Janet Carsten (2019) interprets life in a clinical laboratory through a lens of kinship and argues that laboratory staff are able to make their highly routinised work more meaningful by incorporating other socially valued kinship practices of caring, such as eating together, into their work. The ways in which lab staff reshape and add value to laboratory work, then, show that value is not an inherent quality of a product (lab test) but rather is something shaped by specific working conditions.

At the same time, laboratory staff mentioned being frustrated with the hospital management about often having to go ‘the extra mile’ to procure reagents ‘just to keep the lab running’. As one of the laboratory technicians working in the microbiology department explained:

> All these tests you’re seeing […] and the materials you’re using here are procured by colleague staffs […] Actually, we gave [management] two weeks: “If you don’t procure, we close the lab. We’ll come and then we sit. Any patient comes, we say, ‘No work; no reagent.’” […] We are not happy with the situation and the condition of the lab.

In fact, the lab staff did not purchase *all* the materials themselves—they did not, for instance, buy the reagents for the haematology analyser when they ran out as they were considered too expensive. Nor were they able to procure the expensive reagents for the new molecular department, which was affected by reagent shortages as well.

The willingness to privately procure (some) reagents may thus have been temporary, as explained by a lab technician working in the histopathology department. Situated outside the main lab and behind the reception area, the histopathology section consisted of two rooms and included a range of large pieces of laboratory equipment used to process human tissue samples and prepare them for examination so as to ascertain the presence or absence of cancer. In a corner of the room, next to a window accumulating dust, there were several containers housing tissue samples. The notes on top of one container dated back to 2017. The laboratory technician, who had been working in the laboratory on and off since the 1980s, explained that he had not bought any reagents for the past two years as they were 'too tired' of buying their own reagents. As such, the histopathology department turned back any tissue samples from Connaught, and from other hospitals in the country, as they could not do the tests. Instead of doing diagnostic work, the laboratory technician usually waited on the bench in the reception area and helped out with administrative tasks.

The reagent shortages meant that lab workers covertly charged patients for tests they had to procure themselves. In the reception area, some of the patients my research assistant observed tried to negotiate prices for laboratory tests. Nearly all of the laboratory staff who worked in the main lab had 'pin-codes', meaning they received a government salary, albeit a very low one (just 1.2 million leones per month [~92 GBP]), especially when compared to the salaries of junior doctors, who earned about five times as much. Lab workers often struggled to care for their families. As such, the extra cash earned through selling tests to patients was perhaps another reason why the staff sought out reagents to sell themselves. This was also perhaps the reason why, at times, unofficial workers (i.e., those not on the government payroll) could be seen running tests with blood tubes or rapid tests pulled from their pockets. These practices were rather secretive, but were not invisible. In an interview, one of the international laboratory scientists supporting the lab described it as a 'money-making place', and said, referring to an unsalaried student working the nightshift in the laboratory, 'Why does he [the student] want to volunteer in the night in the lab, yet he studies during the day? There is financial motivation to work.' The infrastructural instability of lab work (related to the erratic supply of reagents and limited supervision of unsalaried staff) enabled the lab staff to privately charge patients for lab tests they bought themselves, thereby providing an economic value for the lab workers in question.

This section makes clear that, in a similar manner as described in Singleton's (1998) study of the UK screening programme's laboratory, Connaught's lab staff's improvisations were able to (temporarily) stabilise the use of diagnostic tests and equipment by incorporating the instability of other institutions (e.g., the government's procurement unit and the hospital administration). However, different from Singleton's argument, the ability of Connaught's lab workers to incorporate infrastructural instability did not provide durable stability. In a more recent study of the labour involved in maintaining the use of a donated radiotherapy machine in Uganda's main public health hospital, Marissa Mika (2020) draws attention to the creativity of Ugandan healthcare workers and explores how they were able to stabilise usage of the machine over time. Whilst improvisation was a part of everyday work in Connaught's laboratory, there also seemed to be a limit to people's willingness and ability to improvise, especially when they felt underpaid and undervalued.

When I returned to the laboratory for a short visit in September 2019, almost the entire laboratory staff, including the manager, had changed as the result of the quality review of laboratory staff conducted by the new Directorate of Laboratory Services. Several young laboratory technicians, many of whom had gained expertise through working in Ebola diagnostic laboratories, were now staffing the different laboratory departments. An ambitious laboratory scientist with international experience was put in charge as the acting manager of the laboratory and instituted many improvements, such as shortening the turnaround of test results to just a few hours, improving quality management systems, and improving supervision and training of staff in the lab. He was also working hard to (re)gain the trust of clinicians by inviting them to the lab and organising meetings where consultants presented to lab staff and explained how they used lab results to inform patient management. Additionally, new research projects funded by Public Health England (PHE) were ongoing and some of the new lab staff, all of whom were enrolled in the Laboratory Sciences undergraduate programme at the medical school, were involved in the comparison of new automated pieces of equipment with manual methods, meaning the molecular department was in use again (albeit only for research purposes). In order to build the capacity of their colleagues, the new lab staff involved other team members in their research project to teach them new molecular methods as well.

One of the few remaining staff members left at Connaught was the laboratory technician who had been waiting for reagents to arrive before resuming his work in the histopathology lab. He was now at work, and happily showed me the storage room, which was packed with boxes full of reagents (e.g., alcohol, lyse buffer, and

wax) provided by a research project investigating the causes of child mortality.[6] The ample amounts of reagents, he estimated, would last the hospital for another 10 years, far beyond the life span of the research project, and enable Connaught Hospital to provide cancer screening services for years to come.

Conclusion

In this research article, I have explored how infrastructure and material things, particularly diagnostic machines and reagents, contribute to the generation of different kinds of value in laboratory work. Through the case study of the unstable haematology analyser, I illustrated how institutional relationships can undermine the clinical value of the laboratory for informing patient care. Sung-Joon Park (2017) used the term 'institutional humiliation' when describing the feelings experienced by nurses working as volunteers in Ebola holding units during a time in which the Sierra Leone government did not live up to its promise to include them on the government payroll. Whilst humiliation was not a term used by the laboratory staff in my fieldwork, it was clear that the actions of clinicians (i.e., not referring patients) and managers (i.e., not ring-fencing or replenishing laboratory reagents) limited the clinical value of Connaught's laboratory to impact patient care; this might be referred to as a form of 'institutional undervaluing' of laboratory work. This shows that, in addition to studying value as it 'emerges in action' (Graeber 2002), it can be insightful to study actions that diminish or undermine the creation of value.

Anthropological research can contribute to understandings of the challenges and solutions associated with durable laboratory strengthening investments. One important insight this ethnographic account of laboratory work provides comes from the analysis of infrastructural instability as inherently political, relational, and institutional; it is not merely a material and logistical issue, as commonly suggested by health systems literature (e.g., Sayed et al. 2018). This research article also adds to the growing body of anthropological literature on improvisation and stability in laboratory medicine (Mika 2020; Singleton 1998) by focusing on the creative ways in which laboratory technicians integrate new equipment into their work even without the usual accompanying social and technological assemblages. Departing from Mika (2020) and Singleton (1998), I have pointed to the limitations of improvisation as a means of improving the clinical value of Connaught's laboratory. The ability of lab technicians to stabilise *some* elements of unstable infrastructure (e.g., the erratic supply of rapid diagnostic tests) but not others (e.g., the expensive

6 The project is entitled Child Health and Mortality Prevention Surveillance (CHAMPS) and is funded by the US Centres for Disease Control and Prevention (CDC), among others. Whilst the research data was considered useful for Sierra Leone given the historic high rates of child mortality, it was aggravating to some of the laboratory staff that the research project was only building up laboratory capacity to screen for causes of death in children; it was not (additionally) assisting with building up general laboratory capacity to conduct culture testing so as to better assess bacterial infections in children who were still alive.

reagents for the haematology machine) showed that their individual improvisations alone did not and could not provide durable stability nor increase the status of the laboratory, as it did in Singleton's study. This implies building sustainable laboratory infrastructure requires attending to the micro-level processes—including mistrust and competition between clinicians, managers, and laboratory staff—as well as macro-level political and economic contexts, including governments' procurement irregularities, which themselves affect infrastructural instability.

Furthermore, this research shows that laboratory tests can generate other kinds of value for lab technicians, such as economic and social value, beyond their primary clinical value: contributing to diagnosis and patient care. Paying attention to the financial structure of hospitals and any cash flows to private and public hospitals (which were beyond the scope of this research) might further illuminate what economic value laboratory tests hold and for whom. Additionally, future research might look into how finance structures and global health investments are fuelling investments in disease-specific devices and private-sector facilities instead of public hospital infrastructures, especially since Sierra Leone was named the second 'hottest' investment country for foreign investment in 2012 (Erikson 2015).

Finally, this research has shown how the research interests of international governments and international funding targeted only at diseases that pose a global security threat (rather than patient care needs) have driven infrastructural investments in the clinical laboratory but done little to improve the clinical value of laboratory tests. This reveals a need for more investment in laboratory infrastructure and testing technologies in low- and middle-income countries to improve routine laboratory capacity in clinical laboratories, rather than in single-disease diagnostic devices.

Acknowledgements

Research for this article was undertaken as part of the DiaDev (Investigating Diagnostic Devices in Global Health) research project (www.diadev.eu), led by Dr Alice Street. This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme, grant agreement No 715450. I am thankful for the guidance of Dr Alice Street and Dr Ann Kelly throughout the undertaking of this research, as well as during its write-up. I also wish to thank Francess Koker for her help with data collection in Connaught Hospital and Dr Mohammed Boie Jalloh, Dr Abdul N'jai, and Dr Tanja Ahlin for providing valuable comments to earlier drafts of the article. Additionally, I am grateful to the anonymous reviewers whose constructive

feedback greatly assisted me in improving my analysis and to Fred Johnson for his copy-editing work. Finally, I thank King's Sierra Leone Partnership and Connaught Hospital's management, laboratory managers and staff, health workers, and patients and their relatives for sharing their time and insights.

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